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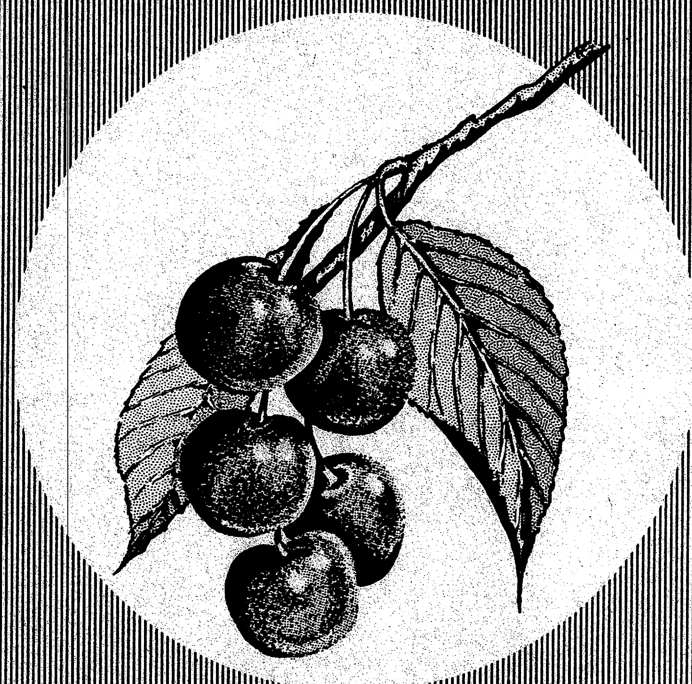
Bruising of RED CHERRIES in relation to the Method of Harvest



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ABSTRACT

Our early studies showed that the bruising of red cherries during harvest is a primary cause of scald blemishes and other defects in cherries to be processed. Two new methods of harvest designed to reduce bruising have been tested and compared to the present commercial method. In the first, cherries were picked with the fingers and permitted to fall onto a self-draining fabric suspended on a frame beneath the tree. In the second, cherries were jarred or shaken manually from a tree onto the suspended fabric.

In the first method, bruising was reduced significantly and the rate of harvest increased slightly. In the second method, there was no change in bruising, and the rate of harvest increased about fourfold. Overall results indicate that major improvements in the harvesting of cherries can be made without lowering quality

Bruising of RED CHERRIES in relation to the Method of Harvest 1/

R. T. Whittenberger and C. H. Hills

THE BRUISING that red cherries undergo during harvesting and processing operations has several significant aspects. It has been shown, for instance, that bruising at harvesttime is a primary cause of scald formation (3, 5, 7, 8, 9, 10, 13)2/, shortens storage life of fresh cherries (11), and accelerates loss of soluble solids from fruit during the soak period (2, 4, 12). Bruising in the processing plant following the soak period may result in faulty pitting, excessive bleeding, and decreased drained weight (11).

In the present method of harvest, cherries are picked individually by hand and are transferred to a pail fastened to the picker at belt or chest height. Haste and carelessness in picking result in bruised fruits. Two new methods of harvest have been tested. In the first, cherries are loosened from a tree with the finger tips and are permitted to fall onto a self-draining minnow net suspended on a frame beneath the tree. The initial work on this method was done by Dr. L. H. Brown of Michigan State University in 1951. In the second method, cherries are jarred or shaken manually from a tree onto the suspended net. Research on this method has been carried out also by Gaston and associates (1).

1/ *Original form of this revised paper was presented at the Eighteenth Annual Meeting of the Institute of Food Technologists, Chicago, Ill., May 28, 1958.*

2/ *Figures in parentheses refer to Literature Cited, at end of this report.*

In this paper, data on bruising, occurrence of scald, rate of harvest, and yield of cherries obtained by the present and the two experimental methods of harvest are presented and discussed briefly.

EXPERIMENTAL

Laboratory tests concerned with the dropping and bruising of cherries on minnow netting were carried out in 1952 and 1953. Field tests of the pick-drop method were conducted in 1953, 1955, 1957, 1958, and 1959, and data on the manual shake method were obtained in 1957, 1958, and 1959. Although each year modifications were made in methods and equipment, similar conclusions could be drawn from the data. In all, 60 trees, located in three commercial orchards of Pennsylvania, two of Michigan, and one of New York, were harvested. Several experiments often were carried out with a single tree. The trees ranged in age from 6 to 30 years, in height from 7 to 18 feet, and in yield of fruit from 20 to 180 pounds. For the calculation of tree volume, the trees were assumed to be spheres.

Equipment. In early experiments a relatively small minnow net (about 6 by 8 feet with 1/4-inch mesh) was used for collecting the cherries. The net was draped over a trapezoid-shaped frame constructed of aluminum tubing and mounted on wheels. Four or five placements of the frame were required in harvesting all cherries on one tree.

In recent experiments, a piece of netting 24 feet square, adequate for covering the entire area beneath a large tree, was used (Figure 1). On two opposite sides the netting was clamped with binder clips to telescoping aluminum tubing. A 12-foot slit in the center of the net enabled it to be slipped beneath a tree and tied at its center to the tree trunk at a point 1-1/2 to 2 feet above ground level. The entire net was elevated with the aid of eight angle-iron stakes about 5 feet in length. Three stakes were used at each of the two edges having the tubing, and one stake at each of the remaining two edges. The edges were fastened to the stakes with hooks. Light

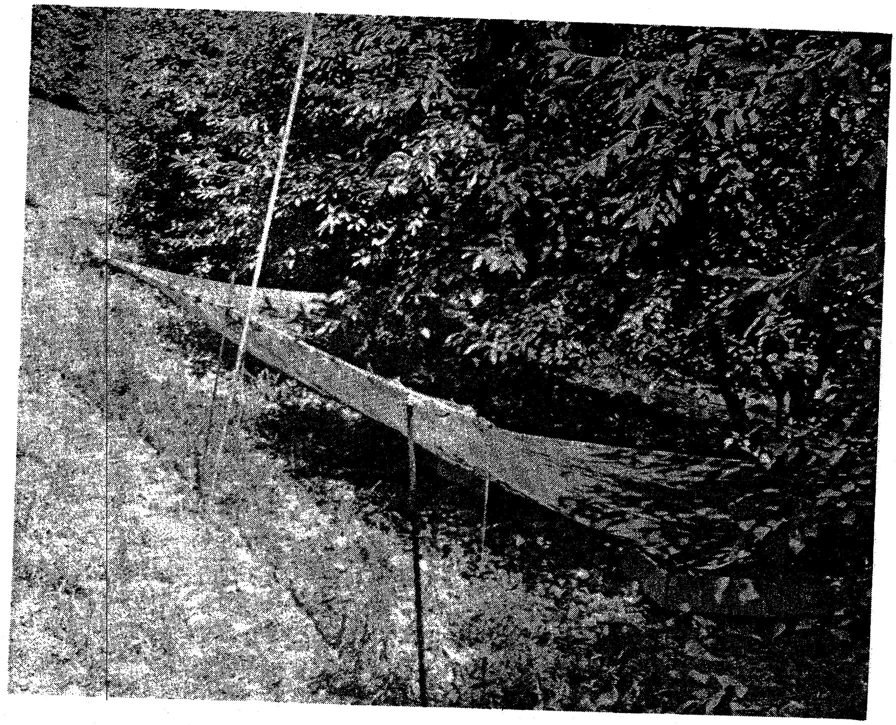

Figure 1 (above)

The netting used for catching cherries was suspended with the aid of stakes and aluminum tubing.

Figure 2 (left)

Pouring and maintaining shake-harvested cherries in cold water immediately after harvest inhibited the development of scald.

rope sewed to the net divided it into four quarters. Drainage was accomplished through a 10-inch slit in the center or low area of each of the quarters. One edge of each slit was weighted with a small piece of chain to facilitate drainage. The plywood collection boxes were about 3 feet square with 6-inch sides (Figure 2).

The collecting assembly was easily set up, taken down, and transported, since the maximum dimension of any dismantled part was 8 feet and the total weight of the assembly, excluding stakes, was 21 pounds. Based on ten tests on both hilly and level terrain, an average time of 9.4 minutes was required for one person to move and set up the assembly. Its size and slope were adjustable; for young trees the assembly at a 16 feet square dimension was adequate.

Owing to its flexibility, the assembly was ideal for experimental purposes. For continued use with the shake method, however, minnow netting is not recommended as a catching material. The netting is too soft and cherries tend to pocket. Gaston *et al.* (1) have obtained good results with light weight, tightly drawn canvas duck.

Procedure of harvest. In the pick-drop method, the picker stood on the ground at the edge of the assembly and harvested all cherries within reach. Both hands were used to lossen cherries which were permitted to drop onto the netting. No cherries were held or squeezed in the hand. Early removal of the low growing cherries prevented them from being struck (and bruised) by cherries from the upper part of the tree as harvesting proceeded. Next, the picker entered the tree through the long slit in the net, and, working from the central bottom to the tree top, harvested the remaining cherries. A small accessory net was used to close the slit. Occasionally a stepladder with a third leg wedged into a branch crotch was used to straddle the assembly and harvest the uppermost cherries.

In the shake method, the lowest and outermost cherries were harvested first as in the pick-drop method. Branches ranging in diameter from one-half to one inch were tapped sharply at an increasing rate with the palm or extended fingers. At an optimum period of vibration, the branches released their cherries. Next, the picker entered the tree center as in the pick-drop method and the hand tapping procedure continued until the harvest was completed. Cherries remaining on the tree were picked by hand, weighed, and used to determine the relative recovery.

Estimation of bruising. The extent of cherry bruising was estimated by a number of methods. In early experiments changes in firmness associated with bruising were measured with a pressure tester (14). Softening was estimated also by feeling cherries with the finger tips. In some cases the storage life of freshly harvested cherries was used as an index of bruising. It has been shown that fresh, unbruised cherries keep without spoilage for a week or more at a cool temperature, whereas bruised fruit spoil rapidly (11).

In later experiments, bruising was estimated from the incidence of scald and from the change in weight of cherries given a standard delay-soak treatment. In contrast with the behavior of unbruised cherries, bruised fruits develop scald blemishes rapidly (3, 5, 13) and may decrease in weight when soaked (4, 12). In the standard treatment, freshly harvested cherries were held at orchard temperature (80° to 90° F.) for 4 to 5 hours prior to being soaked in tapwater for about 20 hours at 70° to 80° F. Although this warm temperature treatment was more severe than that normally given commercially handled cherries, it was very effective in bringing out differences in weight change and scald among the experimental samples. All cherries were blotted to dryness before being weighed. Fruits possessing scalded areas of 9/32 inch or more in diameter were counted as scalded fruit.

Study of pickers. Data on commercial pickers, comprising Mexicans as well as natives of this country, were obtained with the cooperation of the orchard foreman. From his knowledge of the performance of individual pickers, the foreman was able to point out those who did superior, average, or inferior work. The performance of representative pickers, who usually were not informed that they were under observation, was measured. Good cherries spilled on the ground were gathered up and weighed, and cherries left on the tree were picked and weighed. Samples used to estimate bruising were taken directly from the picker's pail before the cherries were sorted or dumped into lugs.

RESULTS AND DISCUSSION

Bruising during present method of harvest. The data of Table 1 indicate that the average commercial picker bruises cherries moderately to severely. Most samples developed appreciable scald and decreased in weight when given the standard delay-soak test. In contrast, the unbruised control samples developed no scald and increased in weight. The wide variation in the degree of bruising by pickers was noteworthy. Many factors, which will not be discussed here, contributed to this variation.

Bruising during new methods of harvest. Early tests in the laboratory showed that cherries could be dropped from a height of 10 feet onto a suspended net with essentially no bruising (Table 2). As the cherries struck the net, it sagged gently, easing their fall. Similar cherries dropped into 2 inches of water or onto a metal surface were moderately to severely bruised. These tests indicated that it could be possible to reduce harvest bruising by means of the pick-drop method.

The extent of bruising of cherries harvested by the three methods is indicated by the data of Table 3. In comparison with unbruised control cherries, all harvested cherries were bruised appreciably, regardless of the method of harvest. From a practical standpoint, however, there was a statistically significant difference in the degree of bruising among the harvested samples. Cherries harvested by the pick-drop method were significantly less bruised than were commercially harvested cherries. The difference in bruising between shake-harvested and commercially picked fruit

Table 1. Scald development and change in weight of cherries harvested by the present method

Picker and test 1/	Area	Scald 2/	Change in weight	
		Commercially 3/ picked cherries	Commercially 3/ picked cherries	Unbruised control cherries
		Percent	Percent	Percent
A	N. Y.	16	+2.1	+3.8
B	do	24	+1.7	+3.2
C	Mich.	35	0	+6.3
D	Pa.	45	-1.2	+3.8
E	Mich.	47	0	+2.4
F	do	48	-0.5	+2.3
G	N. Y.	56	-0.6	+3.5
H	Mich.	74	-3.2	+2.1
I	do	75	-3.8	+2.3
J	N. Y.	80	-0.7	+3.8
K	Mich	85	-2.5	+1.7
L	N. Y.	88	-3.8	+3.5
	AVERAGE	56	-1.0	+3.2

1/ Cherries were given the standard delay-soak treatment.

2/ In all cases, unbruised control cherries developed no scald.

3/ The coefficient of correlation between scald development and change in weight was -.883 (highly significant).

was not significant. In this connection, Gaston et *al.* (1) found that cherries harvested by mechanical shaking compared favorably with commercially picked cherries in respect to bruising.

It is probable that the principal bruising of the pick-drop method occurred as cherries struck branches during the fall through the tree. Shake-harvested cherries were subjected to similar bruising plus that which occurred during the manual shaking of branches. The striking of leaves by falling cherries probably would do little damage, since the leaves would act as baffles or cushions and merely slow the descent of the cherries.

Table 2. Effect of various dropping treatments on the firmness of red cherries as measured with a pressure tester

Treatment of cherries 1/	Firm cherries (orchard 1) Compression Percent	Firm cherries (orchard 1) Compression Standard error	Soft cherries (orchard 2) Compression Percent	Soft cherries (orchard 2) Compression Standard error
1. None, control	19.1	0.591	26.8	0.629
2. Dropped 10 ft., 1X onto suspended net	19.3	.398	28.0	.729
3. Dropped 3 ft., 3X onto suspended net	19.5	.387	27.8	.647
4. Dropped 3 ft., 3X into 2 in. of water	23.8	.591	34.7	.644
5. Dropped 3 ft., 3X onto metal tray	29.5	.714	43.0	1.053

1/ 20 cherries from each treatment were tested for firmness.

Control of scald. Levin and Gaston (6) have pointed out the merits of handling freshly harvested cherries in cold water. In Table 4 data concerning the application of this procedure to shake-harvested cherries are given. Freshly harvested fruit placed immediately in cold water (Figure 2) developed essentially no scald over a 24-hour period. However, a delay of only 2 hours at orchard temperature prior to cooling permitted some of the cherries to scald, and a delay of 5 hours resulted in appreciable scald.

Maturity and shake-harvest. When cherries were green and very immature, they were not released from branches by a standard manual shaking procedure (Table 5). Moreover, picking them by hand left stems (and sometimes spurs) firmly attached to the fruit. As the cherries approached maturity, however, an increasing proportion of them was released by the shaking procedure, and the proportion of attached stems decreased with each harvest. These tests, repeated during two seasons, unfortunately were not continued with the same trees through the mature and overmature stages of the fruit. Nevertheless, separate studies

Table 3. Change in weight of cherries and development of scald as affected by method of harvest. 1/

Method of harvest		Weight change	Scald
		Pct.	Pct.
1. Control, not bruised		+3.8	0
2. Pick-drop		+0.9	21
3. Manual shake		-0.9	49
4. Present commercial		-1.2	56
Analysis of variance:	Deg. of freedom	Mean square	Mean square
Tests	6	5.56*	486
Harvest methods	3	37.05**	4705**
(2) vs. (4)	1	14.81**	4357**
(3) vs. (4)	1	.15	158
Error	18	1.61	266

1/ Cherries given the standard delay-soak treatment. Data are the mean of 7 tests.

* 5% level of significance.

** 1% level of significance.

with 15 different trees showed that when cherries were fully mature, from 90 to 99 percent (average, 94.2 percent) of them were recoverable by the shaking procedure, and from 2 to 18 percent (average, 6.7 percent) of those harvested had stems attached.

Branch shaking and cull fruit. Partly rotted and withered cherries often are loosely attached to their stems. It was thought that cherries of this type might be separated from sound fruit by the selective shaking of branches. Attempts at separation, however, were not particularly successful. In 15 tests, for instance, the very first shake of branches produced an average harvest which comprised 13 percent of the total cherries and contained 19 percent of cull fruit. The average main harvest, obtained by further shaking of the branches, contained 7 percent of cull fruit. There was little or no separation of cherries having wind-

Table 4. Delay and scald development in shake-harvested cherries

Orchard	Scald, percent after 24 hours		
	Delay at about 85° F. before cooling 1/		
	0	2 hr.	5 hr.
A	0	1	9
B	0	7	32
C	3	29	46
D	0	--	34
E	0	8	36
F	0	10	18
AVERAGE	0.5	11.0	29.2

1/ Cherries were cooled and maintained in water at about 40° F. Prior to cooling, they were held in air at orchard temperature.

Table 5. Relation between maturity, stem attachment, and recovery of shake-harvested cherries

Date	Soluble solids content of cherries	Cherry color	Method of harvest 1/		
			Hand pick	Branch 2/ shake	
			Stems on cherries	Stems on cherries	Recovery of cherries
	Percent		Percent	Percent	Percent
6/10	--	green	100	--	0
6/13	7.6	green	72	100	20
6/16	7.8	yellow	55	87	30
6/20	10.9	pink	38	75	46
6/25	12.3	red	6	64	51
7/1	14.2	red 3/	2	24	71

1/ The data are averages of four trees.
2/ A standard shake period of four seconds was used.
3/ Although red in color, these cherries were too immature for satisfactory commercial processing.

Table 6. Rate of harvest of three methods

Tree[1/] tested	Method of Harvest: Present Commercial, Cherries, lbs./hr./worker	Relative rate	Pick-drop, Cherries, lbs./hr./worker	Relative rate	Branch-shake, Cherries, lbs./hr./worker	Relative rate	Concentration of cherries on tree, lbs./100 cu. ft.
A	15	1X	23	1.5X	38	2.5X	0.85
B	21	1X	30	1.4X	73	3.5X	2.27
C	25	1X	33	1.3X	187	7.5X	5.56
D	33	1X	53	1.6X	117	3.5X	1.75
E	43	1X	52	1.2X	154	3.6X	6.67
Average	27	1X	38	1.4X	114	4.1X	3.42

1/ Each tree was divided into three equivalent parts, with each part being harvested by a different method by the same worker. The data include the time required to set up the collecting assembly, move ladders, and perform related tasks.

whip scars. Further research on this subject is contemplated.

Rate of harvest. The data of Table 6 show large differences in the rate of harvest obtained by the three methods. The branch-shaking method was by far the fastest. For instance, the relative rates of the present, pick-drop, and branch-shake methods were 1X, 1.4X, and 4.1X, respectively. Large variations in both relative and absolute rates can be expected, since rate depends on many factors. In the present case, the concentration of cherries on the tree had a pronounced effect. Both of the experimental methods of harvest had a distinct advantage over the present method.

Relation between rate and yield. The harvesting of cherries by manual branch-shaking was divided into three phases as shown in Table 7. In the first, cherries were harvested rapidly by a worker at ground level, and in the second, by the worker within the tree. During these phases, 85 percent of the total cherries were recovered. The third phase, done at a

Table 7. Relation between rate and yield of shake-harvested cherries

Part of tree harvested	Harvested cherries		Rate, 1/ lbs./hr./ worker
	Percent of total	Cumulative, percent	
low	40	40	592
high	45	85	460
scattered patches	11	96	94
remainder 2/	4	100	15

1/ Rate does not include time required for setting up the collecting assembly. Data are averages of five tests, and were obtained by a single worker.

2/ Cherries remaining on trees after shaking were picked by hand.

relatively slow rate, comprised the harvesting of patches of cherries skipped during the first two phases. All three phases accounted for 96 percent of the total fruit, leaving 4 percent still on the tree. This fraction was harvested by handpicking at an exceedingly slow and probably economically unprofitable rate.

Table 8. Loss of cherries during harvest by the present commercial method

Type of loss	Cherries lost, 1/ Percent of total	
	Average	Range
Spilled on ground	3.7	1.7-5.1
Left on tree	1.5	0.9-4.0
Total loss	5.2	3.3-8.6

1/ Data are from 14 tests conducted in four commercial orchards of New York and Michigan.

Recovery of present method. Many factors affect the recovery or yield of the present method of picking cherries. In general, cherries are lost through two principal sources. Pickers spill cherries onto the ground and also fail to remove all sound fruit from a tree. Data of Table 8 show that more cherries were spilled onto the ground than were left on trees. The average total recovery of cherries was 95 percent, a value similar to that obtained by the branch-shaking method.

SUMMARY

Our early studies showed that the bruising of red cherries during harvest was a primary cause of scald blemishes and other defects in cherries to be processed. Means of reducing harvest bruising have therefore been sought, and two new methods of harvesting have been tested. In the first, cherries were picked with the fingers and permitted to fall onto a self-draining minnow net suspended on a frame beneath the tree. In the second, cherries were jarred or shaken manually from a tree onto the suspended net.

Use of the first method reduced bruising significantly and increased the rate of harvest slightly. With the second method, there was no change in bruising, but the rate of harvest was increased about fourfold. With mature fruit, the branch-shake method gave a recovery of 94 percent, a value which compared satisfactorily with that (95 percent) of the present commercial method of harvest. Immature cherries were difficult to remove from branches by shaking, and a high proportion of those removed had stems attached. Placing and maintaining shake-harvested cherries in cold water immediately after harvest inhibited the development of scald blemishes. Overall results indicate that major improvements in the harvesting of cherries can be made without lowering quality.

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